4th Semiannual Progress Report

INVESTIGATION OF THE BASIC PROCESSES OCCURRING IN GASEOUS PLASMA IN VARIOUS CHARGE DENSITY AND ENERGY STATES

Prepared by
L. Goldstein

NASA Research Grant
NGR 14-005-037

For the period
April 1, 1966 to October 1, 1966

Gaseous Electronics Laboratory
Department of Electrical Engineering
Engineering Experiment Station
University of Illinois
Urbana, Illinois

During the reporting period of April 1, 1966 to October 1, 1966, our efforts have been devoted partly (I) to improve and complete the laser heterodyne method as a sensitive diagnostic tool of gaseous plasmas, and (II) to study the interaction of the gas of electrons with the gas of excited atoms in lasering plasmas.

I. The work on the laser heterodyne method of plasma diagnostics can be summarized as follows:

1. In order to minimize the mechanical instability involved in the use of two (He-Ne) lasers, the system described in previous reports has been moved to a concrete floored basement location.
2. The plasma to be studied was placed in the optical cavity of one of the two He-Ne gas lasers used in heterodyning. The plasma is also surrounded on part of its length by a microwave cavity (of $\sim$ 5 GHz resonance frequency) excited in the TM_{010} mode.
3. The plasma of 24 cm length was produced either in argon or in helium at low gas pressures and narrowly pulsed. The lasers were simultaneously oscillating at 0.6328 μ and 1.1523 μ.
4. A change in the forming and/or decaying plasma refractivity resulted in a slight change of the laser frequencies (within the Doppler widths of the laser lines). This change was measured by now standard optical heterodyne techniques with the help of the second He-Ne laser used as reference.
5. A simultaneous microwave cavity measurement of this refractivity enabled us to compare the electron densities down to 10 inches measured by these two independent techniques. The excellent agreement in the results obtained with these methods constitutes a reasonably adequate proof of the correctness of the optical techniques. These results have been submitted for publication in the Applied Physics Letters.[1] A detailed technical report on this work is being printed.

---

[1] J. T. Verdeyen, B. E. Cherrington and M. E. Fein, "Spatially Resolved Laser Heterodyne Measurements of Plasma Densities in Weakly Ionized Gases".

II. The interaction between the electron gas and the gas of the excited atoms made use of a xenon laser. The results of this work are described in due detail in a report to be issued shortly.